

**U.S. PATENT APPLICATION**

**OF**

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**FOR**

**A METHOD AND APPARATUS FOR DISSOLVING UREA**

1                   METHOD AND APPARATUS FOR DISSOLVING UREA

3                   CROSS-REFERENCE TO RELATED APPLICATION

4                   This application claims the benefit of commonly owned and  
5                   copingding U.S. provisional patent application no. 60/438,024,  
6                   filed January 3, 2003.

8                   BACKGROUND OF THE INVENTION

10                  1. Field of the Invention

11                  The present invention relates to a method and apparatus for  
12                  dissolving urea.

13                  2. Problem to be Solved

14                  U.S. Patent Nos. 4,610,714 and 4,710,360 describe a method  
15                  and apparatus for dissolving urea without the use of fossil  
16                  fuel-derived heat. However, the method and apparatus  
17                  described in these patents are complex and require expensive  
18                  equipment and machinery. Such equipment and machinery  
19                  consumes a significant amount of electrical energy.

20                  Furthermore, these patents disclose that it is preferred if  
21                  the method described therein is implemented in warm climate  
22                  areas. Additionally, the method and apparatus disclosed in  
23                  the aforementioned patents may need more than one person to  
24                  operate the apparatus.

25                  Another prior art technique is to mix the urea with hot

1 water. However, such a technique consumes significant amounts  
2 of electrical energy as well as fossil fuel sources in order  
3 to heat the water.

4 Another disadvantage of prior art methods and techniques  
5 is the production of ammonia by-products that typically result  
6 from the heating of the urea in water to relatively high  
7 temperatures (e.g. 130°F, 200°F) in order to accelerate the  
8 solution process to prepare commercial truckload quantities  
9 (e.g. 45,000 lbs. of 50% urea solution).

10 What is needed is a new and improved method and  
11 apparatus for dissolving urea.

12

#### 13 SUMMARY OF THE INVENTION

14 Bearing in mind the problems and deficiencies of the prior  
15 art, it is an object of the present invention to provide an  
16 improved method and apparatus for dissolving urea that  
17 eliminates the problems associated with the prior art  
18 techniques discussed in the foregoing description.

19 It is another object of the present invention to provide a  
20 new and improved method and apparatus for dissolving urea that  
21 does not require directly heating the water or urea.

22 It is a further object of the present invention to  
23 provide a new and improved method and apparatus for dissolving  
24 urea that does not require expensive or complex equipment and  
25 machinery.

1        It is another object of the present invention to provide  
2        a new and improved method and apparatus for dissolving urea  
3        that utilizes relatively less electrical energy than prior art  
4        techniques.

5        It is a further object of the present invention to provide  
6        a new and improved method and apparatus for dissolving urea  
7        that can be used in warm or cool climates.

8        Other objects and advantages of the present invention will  
9        be apparent from the ensuing description.

10       In one aspect, the present invention is directed to a  
11      method for dissolving urea. In one embodiment, the method  
12      comprises the steps of providing a mixing container,  
13      depositing a predetermined amount of urea into the mixing  
14      container, and depositing a predetermined amount of water into  
15      the mixing container. The predetermined amounts of water and  
16      urea form a predetermined urea/water concentration. In one  
17      embodiment, the predetermined urea/water concentration is  
18      about 50/50 wt/wt. The method further comprises the steps of  
19      mixing the urea and water to form a mixture, allowing the  
20      mixture to stand for a predetermined amount of time, and  
21      thereafter, mixing the mixture until the urea completely  
22      dissolves in the water.

23       In a related aspect, the present invention is directed to  
24      a method for dissolving urea comprising providing a mixing  
25      container, depositing a predetermined amount of urea and a

1 predetermined amount of water into the mixing container to  
2 yield a predetermined urea/water concentration, mixing the  
3 urea and the water to form a mixture, monitoring the  
4 temperature of the mixture, allowing the mixture to stand  
5 until the temperature of the mixture reaches a predetermined  
6 temperature, and thereafter, resuming mixing of the mixture  
7 until the urea completely dissolves in the water. In one  
8 embodiment, the predetermined urea/water concentration is  
9 about 50/50 wt/wt. The method further includes maintaining  
10 the temperature of the mixture in the mixing container at the  
11 predetermined temperature. The predetermined temperature is  
12 between about 19°C and 24°C.

13 In another aspect, the present invention is directed to an  
14 apparatus for dissolving urea comprising a mixing container, a  
15 urea dispensing device for depositing a predetermined amount  
16 of urea into the mixing container, a water dispensing device  
17 for depositing a predetermined amount of water into the mixing  
18 container, a temperature sensor to measure the temperature of  
19 the mixture within the mixing container, a temperature control  
20 system for maintaining the temperature of the mixture at a  
21 predetermined temperature, and a control system to control (i)  
22 the urea and water dispensing devices to deposit predetermined  
23 amounts of water and urea into the mixing container to form a  
24 predetermined urea/water concentration, (ii) the mixing  
25 container to mix the urea and the water to form a mixture,

1 (iii) the mixing container to cease mixing to allow the  
2 mixture to stand for a predetermined amount of time, (iv) the  
3 sensor to provide data representing the temperature of the  
4 mixture, (v) the temperature control system to maintain the  
5 temperature of the mixture at a predetermined temperature, and  
6 (vi) the mixing container to resume mixing of the mixture when  
7 the temperature of the mixture reaches a predetermined  
8 temperature and continue such mixing until the urea completely  
9 dissolves in the water to form a solution.

BRIEF DESCRIPTION OF THE DRAWINGS

12 FIG. 1 is a block diagram of an apparatus, in accordance  
13 with one embodiment of the present invention, for carrying out  
14 the method of the present invention.

15 FIG. 2 is a curve of the dissolution time of urea for  
16 various amounts of water initially added to the urea.

17 FIG. 3 is a block diagram of an apparatus, in accordance  
18 with another embodiment of the present invention, for carrying  
19 out the method of the present invention.

## DETAILED DESCRIPTION OF THE INVENTION

22 Referring to FIG. 1, there is shown apparatus 10 of the  
23 present invention. Apparatus 10 generally comprises mixing  
24 container or vat 12 that has a motor-driven mixing blade 13,  
25 shown in phantom. In one embodiment, mixing container 12 is

1 enclosed. In another embodiment, mixing container 12 has an  
2 open top. Mixing container 12 includes outlet 14 for  
3 outputting the product solution. Mixing container 12 can be  
4 configured to be of any suitable size depending on the amount  
5 of the solution that is required. In one embodiment, outlet  
6 14 comprises an electrically controlled output valve. Manual  
7 stirring can be used in place of mixing blade 13. Apparatus  
8 10 includes urea dispensing device 16 that dispenses a  
9 predetermined amount of urea into mixing container 12. In one  
10 embodiment, urea dispensing device 16 includes electrical  
11 controlled output valve 17 to output the desired amount of  
12 urea. Apparatus includes water dispensing device 18. Water  
13 dispensing device 18 comprises outlet 19 that dispenses a  
14 predetermined amount of water into mixing container 12. In  
15 one embodiment, outlet 19 comprises an electrically controlled  
16 output valve. In accordance with the present invention, the  
17 water in water dispensing apparatus 18 is maintained at room  
18 temperature. This feature is described in detail in the  
19 ensuing description.

20 Referring to FIG. 1, apparatus 10 further includes  
21 temperature sensor 20 for monitoring the temperature of the  
22 urea/water mixture in mixing container 12. In one embodiment,  
23 all components of apparatus 10 are electronically controlled  
24 by an electronic control system. Such an embodiment is shown  
25 in FIG. 3 and discussed in detail in the ensuing description.

1        The first step of the method of the present invention is  
2        to add a predetermined amount of urea prills to mixing  
3        container 12. Thus, urea dispensing device 16 outputs the  
4        desired amount of urea prills to mixing container 12. Next,  
5        water dispensing device 18 outputs a predetermined amount of  
6        water to mixing container 12 so as to achieve a predetermined  
7        urea/water concentration. In a preferred embodiment, the  
8        predetermined urea/water concentration is 50/50 wt/wt. For  
9        example, if 40 grams of urea prills are deposited into mixing  
10      container 12, then 40 grams (or ml) of water are added to the  
11      urea prills to achieve a 50/50 wt/wt urea/water concentration.  
12      The predetermined urea/water concentration may be other than a  
13      50/50 wt/wt concentration. The actual predetermined  
14      urea/water concentration may depend upon the amounts of urea  
15      and water being used as well as the particular application at  
16      hand. Furthermore, although the foregoing description is in  
17      terms of the urea prills being deposited first to mixing  
18      container 12, it is to be understood that the water may be  
19      deposited first into mixing container 12 and then followed by  
20      the urea prills.

21       The next step of the method of the present invention  
22      comprises mixing the urea prills and the water so as to form a  
23      mixture. After the mixture is formed, the mixture of urea and  
24      water is then allowed to stand for an amount of time  
25      sufficient to allow the temperature of the mixture to reach a

1 predetermined temperature. In a preferred embodiment, the  
2 predetermined temperature is between about 19°C and 24°C, and  
3 more preferably, about 23°C. The amount of time required for  
4 the temperature of the mixture to reach the predetermined  
5 temperature depends upon the amount of mixture in mixing  
6 container 12. During this time period in which the mixture is  
7 allowed to stand, the temperature of the mixture is monitored  
8 with temperature sensor 20. When the temperature of the  
9 mixture reaches the predetermined temperature, mixing of the  
10 urea/water mixture is resumed and continues until the urea  
11 completely dissolves in the water. The time for urea  
12 dissolution is measured from the moment the mixing resumes to  
13 the point in time when the urea becomes completely dissolved  
14 in the water. The solution is outputted from mixing container  
15 12 via outlet 14.

16 It has been found that increasing the volume of water  
17 initially added to the urea prills substantially decreases the  
18 time for the urea to completely dissolve in the water after a  
19 urea/water concentration of 50/50 wt/wt is achieved. A series  
20 of tests were conducted in order to determine the urea  
21 dissolution time when various amounts of water were initially  
22 added to the urea and wherein additional amounts of water were  
23 subsequently added to attain the 50/50 wt/wt urea/water  
24 concentration. A control test was first conducted in order to  
25 obtain reference data. About 40 grams of urea prills were

1 mixed with an equal amount of water, i.e. 40 grams (or  
2 milliliters). The mixture was not allowed to stand for any  
3 amount of time. Thus, the mixing step began as soon as 40  
4 grams of urea and 40 grams of water were added to mixing  
5 container 12. The time for the urea to completely dissolve  
6 was about twelve (12) minutes and is indicated by numeral 100  
7 in the curve of FIG. 2.

8

9 TEST 1

10 In the first test, about 40 grams of urea and 10 grams of  
11 water were deposited into mixing container 12. The mixture  
12 was then mixed or stirred, and allowed to stand until the  
13 temperature of the mixture reached about room temperature or  
14 about 23 °C. Next, an amount of water necessary to achieve a  
15 urea/water concentration of 50/50 wt/wt was added to the  
16 mixture. Since the initial amount of water was 10 grams, 30  
17 grams of water were added to the mixture to achieve the  
18 desired 50/50 wt/wt concentration. The urea and water were  
19 mixed again. The urea completely dissolved in eight (8)  
20 minutes after the 50/50 wt/wt urea/water concentration was  
21 achieved. This is indicated by numeral 102 on the curve in  
22 FIG. 2. The dissolution time was about 33% faster than the  
23 control test dissolution time of twelve (12) minutes.

24 TEST 2

25 In the next test, about 40 grams of urea and 15 grams of

1 water were deposited into mixing container 12. The mixture  
2 was then mixed or stirred, and allowed to stand until the  
3 temperature of the mixture reached about room temperature or  
4 about 23 °C. Next, an amount of water necessary to achieve a  
5 50/50 wt/wt urea/water concentration was added to the mixture.  
6 Since the initial amount of water was 15 grams, 25 grams of  
7 water were added to the mixture to achieve the desired 50/50  
8 wt/wt urea/water concentration. The urea and water were mixed  
9 again. The urea completely dissolved in seven (7) minutes  
10 after the 50/50 wt/wt urea/water concentration was achieved.  
11 This is indicated by numeral 104 on the curve in FIG. 2. The  
12 dissolution time was about 42% faster than the control test  
13 dissolution time of twelve (12) minutes.

14 TEST 3

15 In the next test, about 40 grams of urea and 20 grams of  
16 water were deposited into mixing container 12. The mixture  
17 was then mixed or stirred, and allowed to stand until the  
18 temperature of the mixture reached about room temperature or  
19 about 23 °C. Next, an amount of water necessary to achieve a  
20 urea/water concentration of 50/50 wt/wt was added to the  
21 mixture. Since the initial amount of water was 20 grams, 20  
22 grams of water were then added to the mixture to achieve the  
23 desired 50/50 wt/wt urea/water concentration. The urea and  
24 water were mixed again. The urea completely dissolved in five  
25 (5) minutes after the 50/50 wt/wt urea/water concentration was

1 attained. This is indicated by numeral 106 on the curve in  
2 FIG. 2. The dissolution time was about 58% faster than the  
3 control test dissolution time of twelve (12) minutes.

4

5 TEST 4

6 In the next test, about 40 grams of urea and 25 grams of  
7 water were deposited into mixing container 12. The mixture  
8 was then mixed or stirred, and allowed to stand until the  
9 temperature of the mixture reached about room temperature or  
10 about 23 °C. Next, an amount of water necessary to achieve a  
11 urea/water concentration of 50/50 wt/wt was added to the  
12 mixture. Since the initial amount of water was 25 grams, 15  
13 grams of water were added to the mixture to achieve the  
14 desired 50/50 wt/wt urea/water concentration. The urea and  
15 water were mixed again. The urea completely dissolved in four  
16 (4) minutes after the 50/50 wt/wt urea/water concentration was  
17 attained. This is indicated by numeral 108 on the curve in  
18 FIG. 2. The dissolution time was about 67% faster than the  
19 control test dissolution time of twelve (12) minutes.

20

TEST 5

21 In the last test, 40 grams of urea and 40 grams of water  
22 were added to mixing container 12 so as to produce a 50/50  
23 wt/wt concentration of urea and water. The urea prills and  
24 water were then mixed or stirred and allowed to stand until  
25 the temperature of the mixture reached about room temperature

1 or about 23 °C. As soon as the temperature of the mixture  
2 reached about room temperature or about 23 °C, the mixture was  
3 mixed or stirred again. The urea completely dissolved in  
4 three (3) minutes after a urea/water concentration of 50/50  
5 wt/wt was achieved. This is indicated by numeral 110 on the  
6 curve in FIG. 2. This dissolution time was about 75% faster  
7 than the control test dissolution time of twelve (12) minutes.

8       Although the ensuing description of TESTS 1-5 were in  
9 terms of allowing the mixture to stand until the desired  
10 temperature of the mixture reached about room temperature or  
11 23 °C, it is to be understood that the desired temperature can  
12 be any suitable temperature in between about 19°C and 24°C.

13       Thus, by increasing the volume of water initially added to  
14 the urea prills, the time for the urea to completely dissolve  
15 in the water substantially decreases once a 50/50 wt/wt  
16 urea/water concentration is attained.

17       Referring to FIG. 3, there is shown another embodiment of  
18 the present invention. Apparatus 200 generally comprises  
19 apparatus 10, described previously herein and shown in FIG. 1,  
20 and electronic control system 202. In one embodiment,  
21 electronic control system 202 comprises a computer having a  
22 data input interface, such as a computer keyboard, to allow  
23 users to input control data. Electronic control system 202 is  
24 in electrical signal communication with output valves 17 and  
25 19 of urea dispensing device 16 and water dispensing device

1       18, respectively, so as to control the output flow of these  
2       devices. Electronic control system 202 is in electrical  
3       signal communication with mixing container 12 to control  
4       mixing blades 13. Electronic control system 202 is also in  
5       electrical signal communication with outlet 14 to control the  
6       flow of solution from mixing container 12. Electronic control  
7       system 202 is also in electrical signal communication with  
8       sensor 20. Specifically, electronic control system 202  
9       receives temperature data from sensor 202 which represents the  
10      temperature of the mixture in mixing container 12 and is  
11      programmed to control mixing blades 13 to resume mixing when  
12      the temperature of the mixture reaches the desired  
13      predetermined temperature. Electronic control system 202  
14      comprises timing circuitry that also tracks the time in which  
15      a mixture of urea and water is allowed to stand before mixing  
16      blades 13 are activated and mixing of the mixture resumes.

17       In a preferred embodiment, apparatus 10 is located within  
18      a controlled environment so as to prevent significant climatic  
19      temperature deviations from having deleterious effects on the  
20      dissolution of urea in the water. For example, as shown in  
21      FIG. 3, apparatus 10 is located in enclosed room 204.  
22      Enclosed room 204 preferably has suitable insulation to  
23      facilitate maintaining a constant temperature within room 204.  
24      Electronic control system 202 is located outside of enclosed  
25      room 204. Enclosed room 204 may be heated or cooled as needed

1 by temperature control system 206. Temperature control system  
2 206 may be configured with any commercially available heating  
3 or cooling means, e.g. air conditioning, furnace, etc. In one  
4 embodiment, a feedback loop is employed wherein electronic  
5 control system 202 receives temperature data from sensor 20  
6 and then controls temperature control system 206 to maintain  
7 the temperature within enclosed room 204 at a desired  
8 temperature (e.g. room temperature).

9 It is to be understood that the actual amounts of urea,  
10 water, and desired solution can be varied depending upon the  
11 application. The foregoing description shall not be construed  
12 as limiting the invention to the relatively small amounts of  
13 urea, water and solution described in the foregoing  
14 description. Thus, the present invention may be used with  
15 significantly large amounts of water and urea to produce a  
16 significantly large amount of solution.

17 It is to be understood that the predetermined urea/water  
18 concentration can be other than 50/50 wt/wt. Specifically,  
19 the predetermined amounts of urea and water may be varied so  
20 as to achieve a urea/water concentration other than 50/50  
21 wt/wt provided that the percent urea does not exceed 50% of  
22 the total weight of the predetermined urea/water concentration  
23 in order to ensure that the urea completely dissolves in the  
24 water at room temperature (i.e. 23 °C). For example, a  
25 predetermined amount of urea may be mixed with a predetermined

1 amount of water so as to achieve a urea/water concentration of  
2 45/55 wt/wt. In another example, a predetermined amount of  
3 urea may be mixed with a predetermined amount of water so as  
4 to achieve a urea/water concentration of 35/65 wt/wt. The  
5 desired urea/water concentration may be varied depending upon  
6 the particular application at hand.

7 Although the foregoing description is in terms of the urea  
8 prills being added to mixing container 12 first and the water  
9 being added thereafter, it is to be understood that the water  
10 may be added first to mixing container 12 and the urea prills  
11 added thereafter.

12 The present invention provides many advantages and  
13 benefits, namely:

14 a) the water with which the urea prills is mixed does  
15 not have to be separately and directly heated, thereby  
16 reducing the overall energy consumption in implementing the  
17 method of the present invention;

18 b) the rate at which the urea prills dissolve in the  
19 water is at least 60% faster than the prior art technique of  
20 mixing the urea with hot water without allowing the mixture to  
21 stand;

22 c) complex and expensive equipment and machinery are not  
23 required; and

24 d) the present invention substantially eliminates the  
25 production of ammonia by-products that typically occur in

1 prior art methods and techniques which heat the urea in water  
2 to relatively high temperatures (e.g. 130°F, 200°F).

3 The principles, preferred embodiments and modes of  
4 operation of the present invention have been described in the  
5 foregoing specification. The invention which is intended to  
6 be protected herein should not, however, be construed as  
7 limited to the particular forms disclosed, as these are to be  
8 regarded as illustrative rather than restrictive. Variations  
9 in changes may be made by those skilled in the art without  
10 departing from the spirit of the invention. Accordingly, the  
11 foregoing detailed description should be considered exemplary  
12 in nature and not limited to the scope and spirit of the  
13 invention as set forth in the attached claims.

14 What is claimed is: